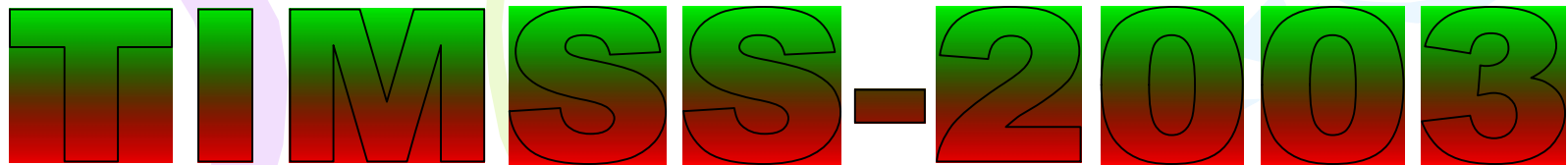


University of Education, Winneba



Trends in International Mathematics and Science Study




**[Ghanaian JSS2 Students' Abysmal Mathematics Achievement in Timss-2003: A Consequence of the Basic School Mathematics Curriculum]**

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# *What was TIMSS-2003?*




TIMSS-2003 is an international study in mathematics and science achievement. At the international level, TIMSS-2003 was designed to measure trends in students' achievement; it also examined the contexts for learning mathematics and science. The results will be useful in guiding policy in education.





# *Who carried out TIMSS-2003?*





The researchers in the Ghana Education Service responsible for administering TIMSS-2003 in Ghana, worked with a number of research organizations during the different phases of the study.



## *Who carried out TIMSS-2003? (contd.)*

Bodies that played significant roles in ensuring the success of the study were:

- 
- The International Study Centre (ISC) in Boston College's Lynch School of Education in USA
  - IEA Data Processing Centre in Hamburg, Germany;
  - Statistics Canada, which was responsible for collecting and evaluating the sample and helping participants to adapt the TIMSS sampling design;
  - Educational Testing Service in Princeton, New Jersey (USA), which carried out the scaling of the achievement data.
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## ***Who took part in TIMSS-2003 in Ghana?***

- In Ghana, TIMSS-2003 involved schools with Year 8 (JSS2) students. There were a total of 5,114 students in 150 schools sampled across the country. JSS2 students in the sample were made up of 45 percent girls and 55 percent boys. The mathematics and science teachers of these students, as well as their head teachers, also provided information on the context in which mathematics and science learning was taking place in their schools.



## *Countries participating in TIMSS-2003*

- Forty-six countries participated in the TIMSS-2003, with six of them from Africa. Three of the countries – Republic of Korea, Malaysia and Singapore - were at about the same level of development as Ghana when Ghana attained its independence in 1957.
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## *Countries participating in TIMSS-2003 (contd).*



Armenia

Australia

Bahrain

Belgium (Flemish)

Botswana\*

Bulgaria

Chile

Chinese Taipei

Cyprus

Egypt\*

England

Estonia

\* African countries participating in TIMSS-2003

Ghana\*

Hong Kong, SAR

Hungary

Indonesia

Iran, Islamic Rep. of

Israel

Italy

Japan

Jordan

Korea, Rep. of

Latvia

Lebanon

Lithuania

Macedonia, Rep. of

Malaysia

Moldova, Rep. of

Morocco \*

Netherlands

New Zealand

Norway

Palestinian, Nat'l Auth

Philippines

Romania

Russian Federation

Saudi Arabia

Scotland

Serbia

Singapore

Slovak Republic

Slovenia

South Africa\*

Sweden

Tunisia\*

United States

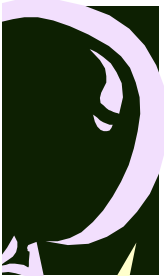


# TIMSS assessment framework for mathematics

- The mathematics assessment framework for TIMSS-2003 was covered by two organising dimensions,

- a content dimension, and
- a cognitive dimension

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- There were five content domains:

- Number,
  - Algebra,
  - Measurement,
  - Geometry, and
  - Data.
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# TIMSS assessment framework for mathematics (contd.)

- **There were four cognitive domains**

- Knowing Facts and Procedures;

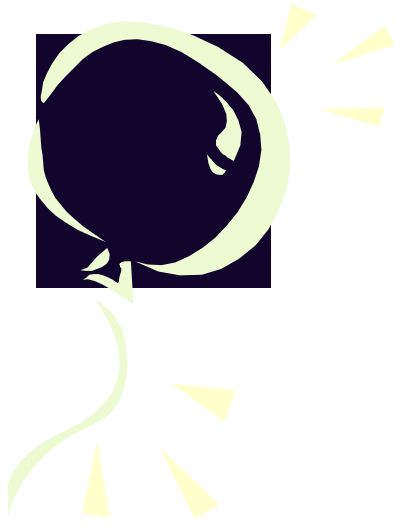


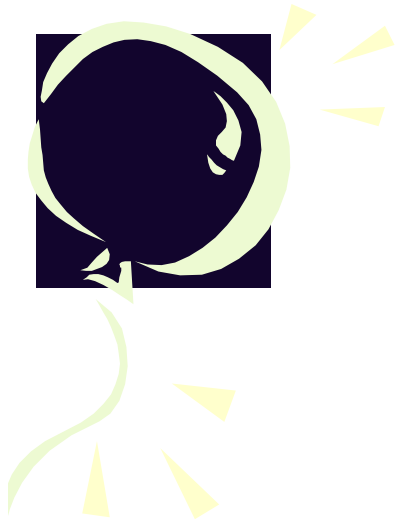
- Using Concepts;

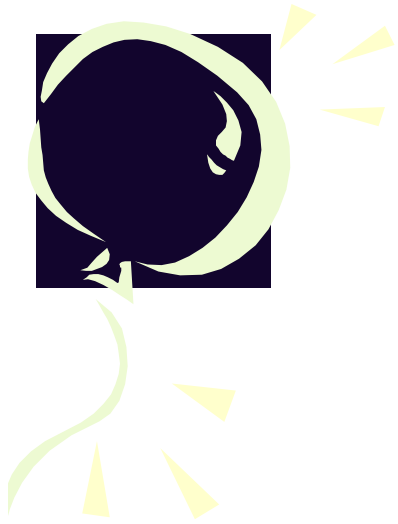
- Solving Routine Problems; and

- Reasoning











## *Ghanaian Students' Achievement in Mathematics*



- The overall performance of the Ghanaian students on the mathematics test was poor. They obtained a low average scale score of 276 which placed the nation second from the bottom of the overall mathematics results table, doing slightly better than only South Africa (Table 1).
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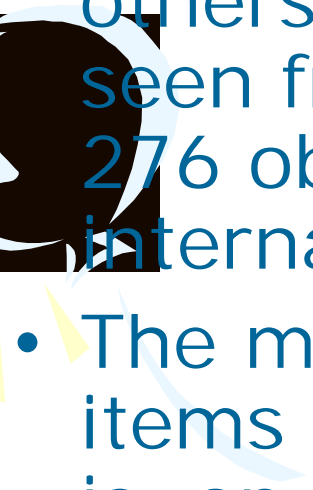

Table 7

# The overall mean mathematics achievement score

Country	Overall Mean Achievement (se)
Ghana	276 (4.7)
<i>Countries Comparable to Ghana at its independence</i>	
Singapore	605 (3.6) h
Korea	589 (2.2) h
Chinese Taipei	585 (4.6) h
Japan	570 (2.1) h
Malaysia	508 (4.1) h
<i>Countries with strong links to Ghana</i>	
England	498 (4.7) h
USA	498 (4.7) h
<i>African Countries</i>	
Tunisia	410 (2.2) h
Egypt	406 (3.5) h
Morocco	396 (2.5) h
Botswana	366 (2.6) h
South Africa	264 (5.5) i
International Average	467 (0.5) h



## *Ghanaian Students' Achievement in Mathematics (contd.)*

- There was a large variation in mathematical abilities among the students with some scoring as low as 130 and others scoring as high as 430. As can be seen from the table, the overall score of 276 obtained was far below the international mean of 467.
  - The mean percentage correct on all test items for each participant was 15%. That is, on the average each student obtained only 15% of the items correct.
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# International Benchmarks

- The performance of all the students can be described in terms of international benchmarks. These constituted the set of items that students reaching each international benchmark were likely to answer correctly and that those at the next lower benchmark were unlikely to answer correctly.







## International Benchmarks (contd.)

- Students reaching a specific benchmark exhibit not only the knowledge and understandings that characterise the benchmark but also the knowledge and understandings of students at the lower benchmark





## **International Benchmarks (contd.)**

- The mathematics benchmarks were described as follows:



**I. Advanced International Benchmark  
corresponding to a scale score of 625,**

**II. High International Benchmark  
corresponding to a scale score of 550,**

**III. Intermediate International Benchmark  
corresponding to a scale score of 475, and**



**IV. Low International Benchmark  
corresponding to a scale score of 400.**



## International Benchmarks (contd.)

- The analysis of achievement at these benchmarks indicates that three major factors differentiated performance among the four mathematics benchmark levels:
  - The mathematical operation required;
  - The complexity of the numbers and number system
  - The nature of the problem situation.





## International Benchmarks (contd.)

- At the lower benchmark, student performance reflected acquisition of some basic mathematical knowledge such as addition, subtraction and multiplication of numbers whereas at the advanced benchmark, student performance reflected the use of relatively complex algebraic and geometric concepts and relationships.





## Ghana's performance on the International Benchmarks in mathematics

- In mathematics, over 80% of the students did not reach the low international benchmark. This implies that majority of our students have no good grasp of knowledge and conceptual understanding of basic mathematical principles, and could therefore not apply these in the problem situations.



## % of Students Reaching International Benchmarks

Countries	Advanced	High	Intermediate	Low
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### *Countries Comparable to Ghana at its independence*

Singapore	44	77	93	99
Chinese Taipei	38	66	85	96
Korea, Rep.	35	70	90	98
Japan	24	62	88	98
Malaysia	6	30	66	93

### *African Countries*

Egypt	1	6	24	52
South Africa	0	2	6	10
Morocco	0	1	10	42
Tunisia	0	1	15	55
Botswana	0	1	7	32
Ghana	0	0	2	9

### *Countries with strong links to Ghana*

England	5	29	64	90
United States	7	41	75	93




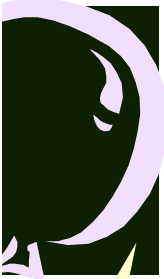
## **Implication of Ghana's poor performance on the International Benchmarks (contd).**

- The educational system in Ghana where only 13 percent of the students reached the low benchmark does not appear to provide adequate preparation for its students.**





# Achievement in mathematics content areas

- Students' performance in all the five mathematics content areas were significantly lower than the international means.
  - In terms of the type of items used, 21.6% of the students obtained responses on multiple-choice items as compared with 12.1% that got correct responses on constructed response items (from released items).
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# Gender differences

- Overall, boys performed better than girls in both mathematics and science.



- In all the mathematics content areas except measurement, there was a statistical difference between girls' and boys' mean achievement with the boys achieving higher scores than the girls.






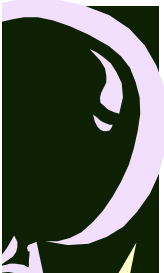
# Contexts for learning: Introduction

- To provide a context for interpreting the achievement results, detailed information on students' home backgrounds, how they spend their time out of school and their attitude towards mathematics and science was gathered from the students taking part in the study.





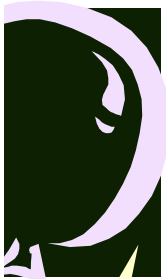
## Contexts for learning: Introduction (contd.)

- The mathematics and science teachers of these students, as well as their head teachers, were also made to provide information on the context in which mathematics and science learning was taking place in their schools.
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# Parents' educational background

- Majority of students (37%) had parents whose highest level of education was junior secondary school.
- The results indicate a positive correlation between the level of education of the parent and achievement of the child/children in school.

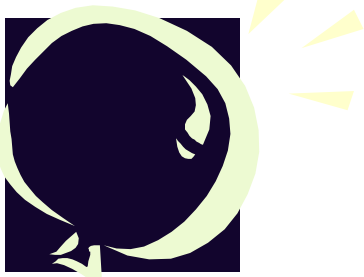




# Student's Educational Aspiration

- **Students with higher aspirations performed better in science and mathematics than those who did not have such aspirations.**





# Self-confidence

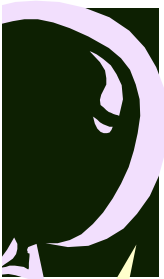
- Having high self-confidence in science and mathematics seemed to be associated with better performance in science and mathematics






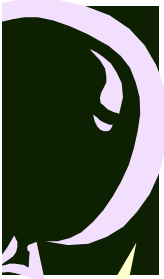
# Students' valuing science and mathematics

- **Students who have high value for science generally had a higher mean achievement.**






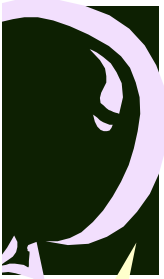
# Leisure activities during a normal school day

- Students spent most of their leisure time reading books, doing jobs at home, playing sports and playing or talking with friends. However, the major activity at leisure time, reading a book for enjoyment, did not reflect on achievement
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# Time spent on homework and achievement

- Time spent on homework was associated with higher achievement in science and mathematics.
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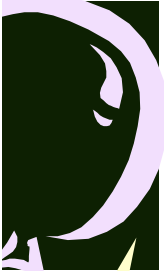
## Role of availability of educational resources at home on student achievement

- Educational resources such as books and study tables/desks had positive effect on achievement in science and mathematics.





# English Language usage and achievement

- Majority (68%) of JSS2 students in Ghana either never spoke English or did so sparingly. Students from homes where English Language is always or almost always spoken achieved higher mean scores than those who spoke it less frequently.
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## Approaches and processes emphasised in mathematics and science

- A lot of emphasis is placed on learners knowing basic science facts, understanding science concepts, learning about the nature of science.


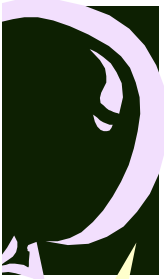


- Emphasis is placed on mastering basic skills, understanding mathematical concepts and principles




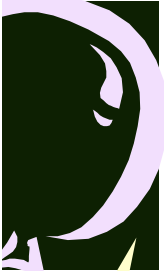


# Meeting the needs of groups of students with varying abilities

- No provisions are made in the mathematics and science syllabuses and textbooks for differentiating the intended curriculum to meet the capabilities of groups of students with varying abilities.
  - Singapore, where the best results were reported in both subjects, practices even a more extreme form of the differentiation
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# TIMSS topics taught by the teachers

- The teachers' responses indicate that the average proportions of students taught all the TIMSS-2003 science and mathematics topics were 48% and 60% respectively.
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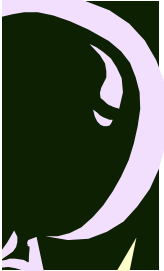
# Certification, Gender and age

- Most junior secondary school mathematics and science teachers do not hold university degrees.

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- Half of the students were taught by inexperienced young certificate 'A' teachers who are in their twenties.



# Professional interactions among teachers

- About a quarter of the students were taught by teachers who never interacted with other teachers.
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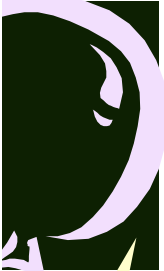
# Readiness to teach mathematics and science

- Teachers of almost all the JSS2 students felt ready to teach nearly all the topics in the five science content areas.
- The science teachers felt more ready to teach Physics and less ready to teach Earth Science.





# EXTENT OF STUDENT participation in the teaching-learning process

- There seemed to be more emphasis on demonstrations instead of group work and students performing their own experiments and/or investigations.
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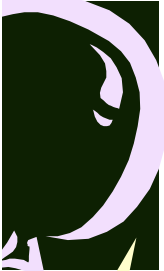
# Textbook usage

- Majority of mathematics and science teachers reported they used textbooks as supplementary resource since no matching textbooks for the revised curriculum have been supplied to schools.





# Utilisation of class time

- The three most predominant activities accounting for class time were listening to lecture style presentations, working problems with teacher's guidance and working problems independently
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# Level of homework and achievement

- Teachers used homework as the basis for class discussion and for students to correct errors in their homework in class.





# Nature of assessment items and achievement

- Students whose teachers used only constructed response items had lower achievement than those whose teachers used only multiple-choice items or those whose teachers used a combination of multiple-choice and constructed response items.
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# School characteristics

- The achievement of the students decreased as the percentage of economically disadvantaged students increased.





## Heads and teachers' perception of school

- There was a strong positive correlation between the Heads' perception of the school climate and achievement.



- There was a positive relationship between teachers' perception of school climate and achievement in mathematics







# Recommendation 1

- Since English is the medium of instruction, its teaching in schools should be strengthened.



- In addition, problem solving activities in mathematics and science should provide context for teaching students reading and comprehension.



- Science and mathematics teachers should collaborate with language teachers to assist students to overcome difficulties encountered in reading, comprehension and writing.



## Recommendation 2

- The GES, in collaboration with science and mathematics subject associations and the teaching universities, should provide regular in-service education and training (INSET) for science and mathematic teachers.





## Recommendation 3

- The teacher education universities, UEW and UCC, and the teacher training colleges should re-examine the content and pedagogy of their mathematics and science education programmes to ensure that their products can not only effectively teach the topics included in the programmes but also encourage the development of higher cognitive abilities





## Recommendation 4

- Currently, very few parents involve themselves in the academic work of their children, even though their involvement can enhance their children's performance. Parents can provide a conducive physical and psychological environment at home for learning.
- Parents in addition should be encouraged to assist their children with their homework as well as participate in raising funds for schools, and participate in mathematics and science fairs.





## Recommendation 5

- The Science Technology and Mathematics Education (STME) Clinic, organised annually by the GES to encourage students, especially girls, to study science and mathematics at the pre-tertiary level, should be re-organised to ensure that its content addresses the difficulties encountered by students in science and mathematics





## Recommendation 6

- The Ministry of Education with the support of development partners should put in place measures to double the number of female teachers in mathematics and science in the next five years. More females should be encouraged to enrol in science and mathematics education programmes at the universities and the diploma awarding teacher training colleges.





## Recommendation 7

- A gradual attempt should be made to supply computers and associated software to all junior secondary schools. Where computers are available, they should be used to facilitate learning of science and mathematics. Before this, teachers should be given training to develop expertise in the use of computers for educational purposes.





## Recommendation 8

- The policy of not allowing the use of calculators in the classroom needs to be reviewed.







## Recommendation 9

- Resources for teaching science and mathematics should be made available to schools. The CRDD should make a list of basic resources required to implement the science and mathematics curricula and encourage schools to acquire as many of these as possible. District assemblies should assist in the provision of these resources.



## Recommendation 10

- The national curriculum for science and mathematics should be reviewed to emphasise the investigative and problem solving aspects of the subjects – designing, planning and conducting experiments or investigations, learning about technology and its impact on society, and solving non-routine problems.





## Recommendation 11

- Recommended textbooks and teacher's handbooks that match the revised syllabuses for mathematics and science should be made available for teachers. The textbooks should meet the needs of the teachers. The Ministry of Education's textbook policy, which provides schools with variety of textbooks on the same subject from different publishers, should be vigorously pursued.





## Recommendation 12

- Teachers should give more relevant and challenging homework (that demand higher cognitive abilities) to students. These assignments should be marked and discussed with students on time.





## Recommendation 13

- MOEYS to support structures such as science and mathematics clubs, school-university partnerships to promote the teaching of science and mathematics in rural and urban schools.





## Recommendation 14

- Inspectorate Division of the GES should be adequately resourced (with human, material and financial resources) to provide effective monitoring and supervision of instruction in science and mathematics in the schools to ensure that learning takes place.





## Recommendation 15

- The government should provide differential packages for science, mathematics, and technical/vocational teachers. This hopefully will reduce the high attrition rate in science and mathematics teachers as well as encourage graduate teachers to teach at the JSS level.





## Recommendation 16

- The CRDD of the GES should develop minimum competencies or standards of performance in science and mathematics to be mastered by students at JSS level. This will make teachers responsible for ensuring students' mastery of the defined competencies.

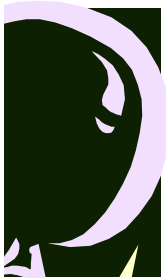






## Recommendation 17

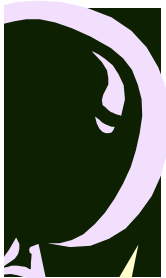
- Government should provide adequate funding to support science and mathematics education in the junior secondary schools.





## Recommendation 18

- The Ministry of Education should continue to support Ghana's participation in future TIMSS so as to continue to monitor trends in Mathematics and Science education in the country.





## Recommendation 19

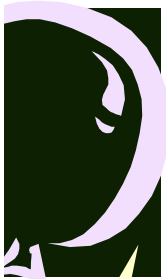
- The Ministry of Education should constitute the task force to study the recommendations and see to their implementation

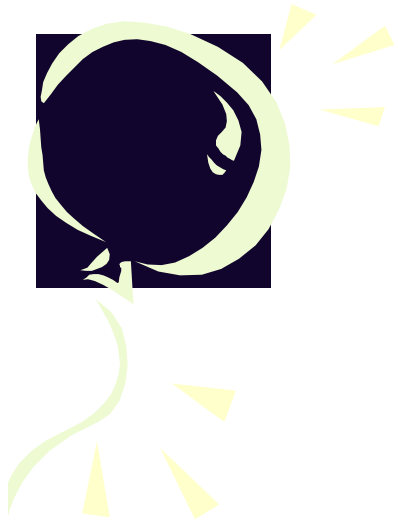




# Finally

- This summary has provided description of the performance of Ghana JSS2 students in mathematics and science together with the contextual factors that impact on effective learning.
- It has only presented a bird's eye view of the problem. A more detailed account can be found in the national report on Ghana's participation in TIMSS-2003.





THANK YOU